Attorney's Docket No.: 06618/733001 / CIT 3338

APPLICATION

FOR

UNITED STATES LETTERS PATENT

TITLE:	IMPROVED ELECTRODE AND INTERCONNECT FOR MINIATURE FUEL CELLS USING DIRECT METHANOL FEED
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IMPROVED ELECTRODE AND INTERCONNECT FOR MINIATURE FUEL CELLS USING DIRECT METHANOL FEED

STATEMENT AS TO FEDERALLY-SPONSORED RESEARCH

[0001] The invention described herein was made in the performance of work under a NASA 7-1407 contract, and is subject to the provisions of Public Law 96-517 (35 USC 202) in which the Contractor has elected to retain title.

CROSS-REFERENCE TO RELATED APPLICATIONS

[0002] This application claims priority from Provisional application number 60/253,423 filed November 27, 2000.

BACKGROUND

[0003] Direct methanol fed fuel cells may be used as energy sources. Miniaturization of these devices may allow the devices to replace rechargeable batteries in certain applications. Such applications may include, for example, cellular telephones, laptop computers, and other small portable electronic devices.

[0004] The electrode configuration of these devices may form a critical factor about the performance of such fuel cells. Resistance between interconnects may also form a factor.

SUMMARY

[0005] The present application teaches an electrode and interconnect technique which may be more efficient than previous techniques, as well as enabling reduction of size.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] These and other aspects will now be described in detail with reference to the accompanying drawings, wherein:

[0007] Figure 1 shows a first interconnect technique; and

[0008] Figure 2 shows a second interconnect technique, in which the current passes through the membranes and the interconnects.

DETAILED DESCRIPTION

[0009] Methanol fuel cells may be constructed as described in U.S. patent number 6146781. However, these systems often use bipolar plates, often called "biplates", between the stacks. These bipolar plates may be too large for effective miniaturization.

[0010] A flat pack design has been disclosed. This flat pack technique may operate without biplates. Instead, the

cells are connected in series on a common membrane plane, using electrical interconnects which are formed through the membrane.

[0011] This technique, although compact and lightweight, may result in a higher internal resistance than that of the bipolar cell, which would have the same active electrode areas and the same number of cells.

[0012] The higher internal resistance may lower the power density and also lower the efficiency.

[0013] Power density that has been attained with a first generation flat pack was in the range of 2-3 mw per centimeter squared. However, it may be desirable to increase that power density, for example to as high as a 8-10 mw/ cm^2, in order to meet requirements of portable power source applications. The inventors accordingly realized that the high internal resistance of a flat pack may be an important part of increasing power density of the direct methanol fed fuel cell.

[0014] The present application teaches a flat pack design which reduces the path length for the current flow, and increases the area of the interconnect. By carrying out both of these objectives substantially simultaneously, the internal resistance may be reduced.

[0015] The electrodes of the first embodiment may allow use current to flow along the length of the electrodes. The effective path length for the current flow may be given by one arbitrary unit for each 1 cm x 1cm section of the electrode. Thirty units of path length may be used for the six cell pack. For example, all the current through the cells passes through an interconnect area of approximately 0.15 cm^2. The ratio of the interconnect area to the electrode area is approximately 0.03. Moreover, the pack has a resistance of about 9.6 ohms.

[0016] In the figure 1 embodiment, the current flow from a first unit 100 occurs in the direction of the arrow 102. In the embodiment, a common membrane may be used, or membranes parts may be connected.

[0017] A number of separate cells are formed, each having electrodes with different parts. Interconnects operate to connect between the respective interconnects. For example, interconnect 118 connects between the cell including membrane 110 and the cell including membrane 112. Similarly, a second interconnect 122 connects between the cell including membrane 112 and the cell including membrane 114. In this embodiment, the cells are connected through the membrane interconnect. The current flows along the

length of the cells from one interconnect to the other. Overall current flows from the cathode 99 to the anode 107.

[0018] A second embodiment is shown in figure 2. In this embodiment, larger area interconnects are used with parallel current paths. In this embodiment, the current flows in parallel through the width of the cell, along and through the membranes and the interconnects. This system may use a catalyst layer coating and membrane electrode assembly formation of a type which has been known in the art.

[0019] A first membrane 200 is planar, as conventional, and the current flow passes through the membrane. An electrode is associated with the membrane. Interconnect 202 is similarly planar, and associated with the electrode and membrane. Similarly, a second membrane 210 is connected using a second interconnect 214. This effectively forms a strip cell in which current flows through the width of the cells, and the cells are connected through the interconnect along almost the entire area of the cell. For example, the interconnect may be over 90 percent of the area of the membrane.

[0020] An advantage of this system is that the current flows across the pack. The effective path length is approximately 6/5 units, because there are five parallel

segments of resistance, each about equal to six arbitrary units of length. The ratio between the interconnect area and the electrode area is approximately 0.2. Also, the pack has an internal resistance of about three ohms.

[0021] In order to formulate this new layout and interconnect, the system uses new types of masks for appropriately overlapping electrodes and interconnects. The interconnect materials which are used are of a type that retain their form prior to curing. In addition, the interconnect material is applied in a controlled manner, as a 1 mm wide line segment.

[0022] The masks may be formed of Kapton materials that are 3-5 mils thick. The electrodes are sized appropriately to fit the masks. An interconnect paste is formulated from a high surface area conducting carbon material such as Astbury graphite and that he curing binder in the weight ratio 20 : 1. Isopropanol is added in small amounts to the paste in order to achieve appropriate consistency. This formation technique results in formable interconnects which do not flow excessively, and which their retain their connection, allow optimum electrode alignment prior to membrane electrode assemblies being hot pressed. The system may be applied using a hypodermic syringe loaded with interconnect paste of an appropriate consistency.

[0023] Although only a few modifications have been disclosed in detail above, other modifications are possible. All such modifications are intended to be encompassed within the following claims, in which: